

Hydrogen Research & Innovation Days

24-25 November 2025





MULTHYFUEL: SAFETY AND PERMITTING FOR HYDROGEN AT MULTIFUEL RETAIL

Dinko Durdevic

Green Sustainable Solutions

Hydrogen Research & Innovation Days

24-25 November 2025



Call year:
2020

Call topic:
FCH-04-1-2020

Project dates:
01/01/2021 - 31/09/2024

Total project budget:
2,109,906.25 €

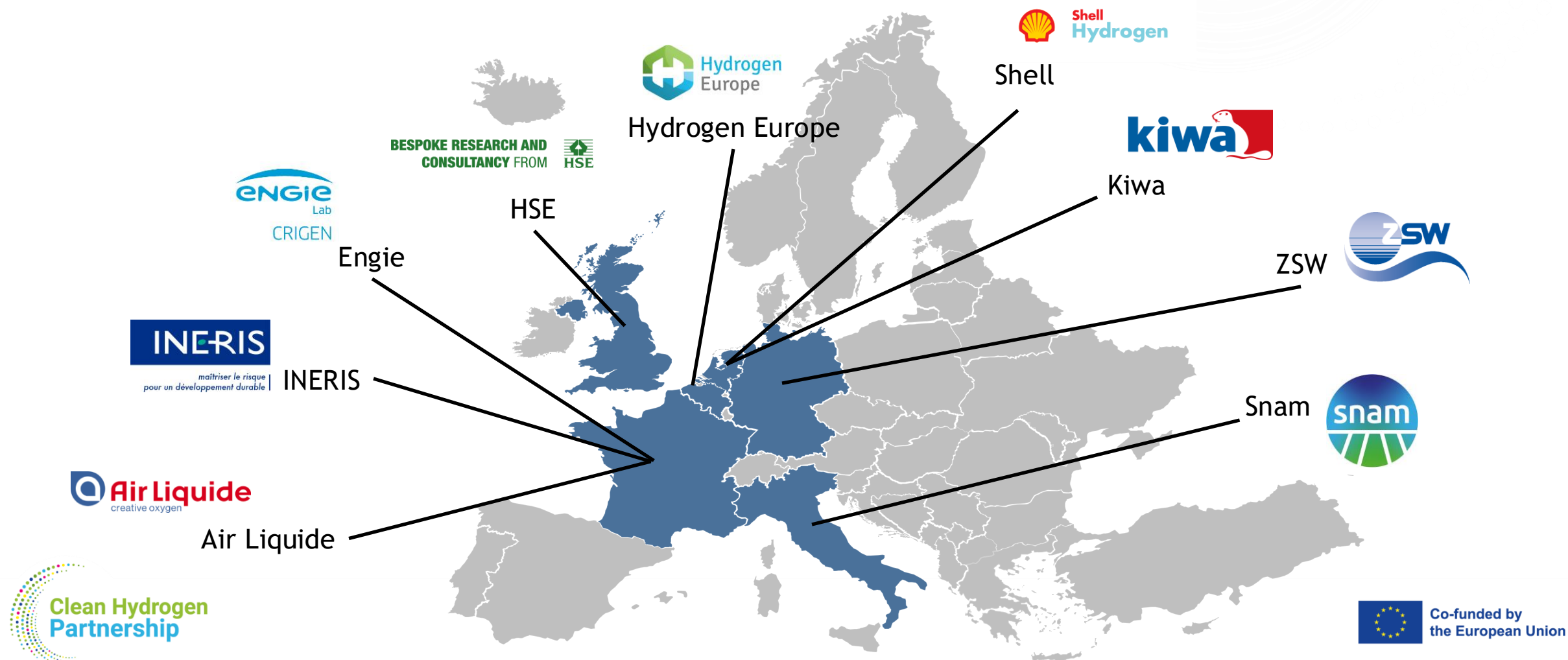
MultHyFuel

Finalised in 2025

**Clean Hydrogen Partnership max.
contribution: 1,997,406.25 €**
Other financial contribution:
112,500.00 €



Partners

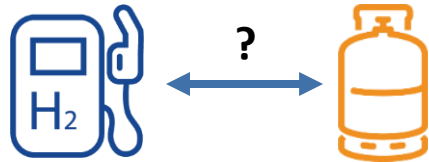




Project Summary

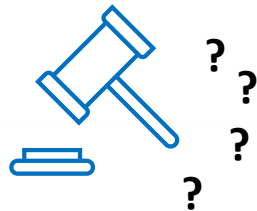
Context:

Increased demand for upscaling and co-locating HRS alongside conventional fuels in commercial and residential areas



Problems:

- Lack of specific HRS regulation in some countries
- Co-location of hydrogen with conventional fuels not foreseen in most safety regulations
- Different approaches



Goals:

- Identification of *relevant gaps* in the current legal and administrative framework;
- Acquisition of *experimental data* from engineering research on hydrogen leaks, their effects and the effects of mitigation measures;
- *Active engagement* with a community of stakeholders in the overall process;
- Successfully disseminate the project's results.





WP structure

WP6 – Project management

WP1 - Detailed investigation of current status

T1.1 Definition of scope for regulatory analysis (Cross-country research framework)

T1.2 Research into permitting requirements and public guidance on required risk assessments

T1.3 Comparative assessment and gap analysis

WP3 - Generate best practice guidance

T3.1 State of the art of technology

T3.2 State of the art on risk assessment methodologies

T3.3 Preliminary risk analysis

T3.4 Detailed risk assessment

T3.5 Identification of critical scenarios

T3.6 Risk assessment review of critical scenarios & hazardous areas

T3.7 Best practice guidelines redaction

WP2 - Practical research to address gaps in current understanding

T2.1 Leakage characterisation of H2 dispensers

T2.2 Fire and explosion hazards

Task 2.1.1 Leakage characteristics

Task 2.1.2 Dispersion characteristics

Task 2.1.3 Ignition probabilities

Task 2.1.4 Efficiency of safety barrier

Task 2.2.1: Defining a zoning threshold

Task 2.2.2 Domino effect arising from faults on hydrogen dispensers

Task 2.2.3 Vulnerability of hydrogen dispensers to incidents involving other fuel dispensers

WP4 – Engagement

T4.1 Establishment of the Network

T4.2 Inception phase

T4.3 Workshop on state of the art and case study models

T4.4 Workshop on refined case study models and WP2 methodology

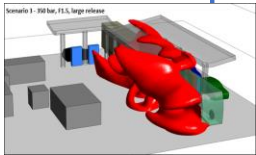
T4.5 Workshop on results of WP2 and WP3

T4.6 Workshop on development of best practice guidance

T4.7 Meeting on adoption of best practice guidance (WP3)

WP5 - Dissemination, Communication and exploitation

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Severe
Almost Certain	Medium	High	High	Extreme	Extreme
Likely	Medium	Medium	High	Extreme	Extreme
Possible	Medium	Medium	High	High	Extreme
Unlikely	Low	Medium	Medium	High	High
Rare	Low	Low	Medium	High	High





Regulatory & Permitting Insights

- **Inconsistent rules:** Discovered that HRS safety regulations differ widely across countries.
E.g. some nations (NL, FR) require formal quantitative risk assessments with set criteria, while others have no specific H₂ guidelines, leaving operators to interpret general rules.
- **Variable safety distances:** Prescribed separation distances between H₂ equipment and other fuel infrastructure range significantly (e.g. 6–14 m or more).
One standard H₂ station layout doesn't fit all countries' rules under current regimes.
- **Permitting gap:** This patchwork of rules makes approvals slow and uncertain. MultHyFuel highlighted the *need for harmonized EU-wide permitting standards*, so HRS can be deployed faster and more uniformly.

(Findings were shared with regulators to inform common codes.)



Hydrogen Safety Experiments

- **Real-world testing:** Simulated high-pressure H₂ leaks (up to ~875 bar) at a dispenser, followed by controlled ignitions. These full-scale tests provided vital data on flame size, heat and overpressure in actual accident scenarios.
- **Invisible flames:** Found that H₂ fires are nearly invisible to the naked eye – a small flame was seen in normal camera images, but thermal imaging revealed a large, far-reaching jet fire.
- **Scenario coverage:** Experiments covered a range of leak sizes from minor hose leaks to major ruptures, both in open air and within an enclosed dispenser. Data were collected to validate gas dispersion models and refine safe separation distances for H₂.
- **Safety measures tested:** Evaluated the effectiveness of engineered safeguards (e.g. emergency shut-off valves, pressure relief devices, breakaway couplings). Results confirmed that rapid-acting safety systems and proper ventilation greatly mitigate the consequences of leaks and fires.





Key Experimental Findings & Innovations

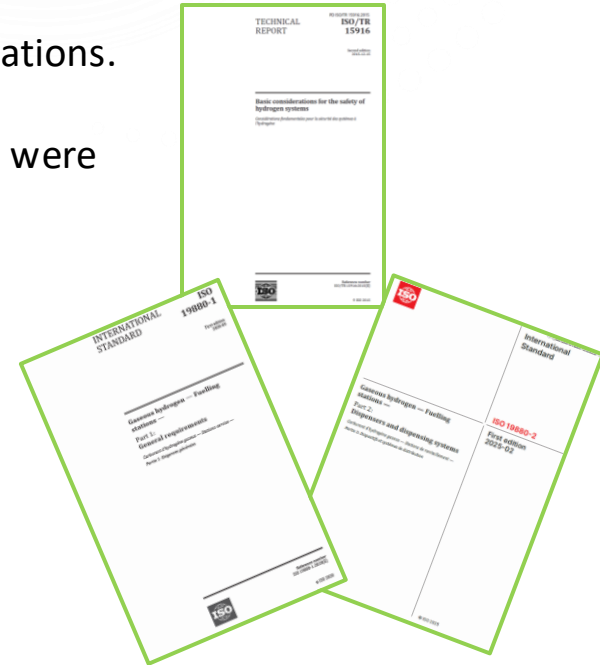
- **Large gas clouds:** Even a “medium” H₂ leak can produce a substantial flammable gas cloud before ignition. This reinforces the need for adequate spacing and ventilation to prevent vapor buildup at multi-fuel stations.
- **Ignition probability:** The likelihood of ignition is very high for major releases (almost certain for a catastrophic rupture). For smaller leaks, ignition still occurs ~10–20% of the time.
- **Fast response critical:** Tests showed that if ignition occurs, flames and pressures develop within milliseconds. Safety systems must activate extremely fast (automatic shut-offs, venting) to effectively mitigate explosions.
- **Risk assessment tool:** The project developed a predictive failure database/tool for H₂ equipment. This helps estimate leak frequencies and outcomes even with limited historical data – an innovative aid for designing stations and informing risk-based regulations.





Good Practice Guidelines - Outputs

- **H₂ Risk Assessment Framework:** Practical methodologies for evaluating H₂-specific risks at multi-fuel stations.
- **Design & Operation Best Practices:** Comprehensive recommendations for station layout and operation were compiled (optimal dispenser placement, use of protective barriers and canopies, sensor and alarm integration, ...).
- **Evidence-Based Safety Criteria:** Guidelines backed by experimental data (scientific evidence builds confidence in the proposed measures).
- **Stakeholder-Vetted Solutions:** Guidelines co-developed with input from regulators, standardization bodies and industry experts. This ensures recommendations are practical, enforceable and widely accepted by end-users.
- **Standards Alignment:** European codes (ATEX zoning, ISO standards for H₂ fueling). Include recommendations to update standards and close regulatory gaps.





Impact and Adoption

- **Informing Policy:** Science-based input for regulators = update of safety regulations for H₂ refuelling based on solid evidence, enabling the safe expansion of H₂ infrastructure.
- **Empowering Industry:** Station operators, fuel providers and equipment manufacturers benefit from clear, validated best practices.
- **Public Safety & Trust:** The implementation of MultHyFuel's safety measures will protect the public and nearby facilities, addressing common safety concerns. H₂ = reliable, safe alternative fuel.
- **Guiding Future R&D:** Researchers and standards organizations can leverage the identified knowledge gaps and data.
 - Highlights where further research is needed (e.g. more extreme scenarios, new technologies), ensuring continuous improvement in hydrogen safety and standardization.





Conclusion & Next Steps

- **Safer Hydrogen Deployment:** 1st EU-wide guidelines for safely integrating H₂ into conventional fuel stations.
- **Harmonization underway:** Already influencing updates to codes and standards.
- **Moving forward:** Ongoing collaboration with initiatives like the European Hydrogen Safety Panel will help translate these best practices into formal regulations. Future work will address remaining questions (e.g. new materials, larger-scale systems) to further refine safety measures.
- **Key message:** *With common guidelines and robust safety data now available, Europe can accelerate hydrogen mobility with confidence – ensuring that the transition to clean energy is underpinned by rigorous safety and public trust.*



Thank you for your attention!

info@multhyfuel.eu



MultHyFuel

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (now Clean Hydrogen Partnership) under Grant Agreement No 101006794. This Joint Undertaking receives support from the European Union's Horizon 2020 Research and Innovation programme, Hydrogen Europe and Hydrogen Europe Research.

